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Release Pattern of Inorganic N, Phosphorus and Potassium as Influenced by Farmyard Manure and Pressmud Compost under Laboratory Incubation Study

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A B S T R A C T

Knowledge of the nutrient release from organic residues helps in optimizing nutrient effciency in agricultural crop production systems. A laboratory incubation experiment was conducted in Completely Randomized Design to assess the release of Ammonical-N, Nitrate-N, available Phosphorus and Potassium in soil incubated with two organic sources *viz.* farmyard manure and pressmud compost (T_0= Control, T_1= 5 MT ha^{-1} organic manure, T_2=10 MT ha^{-1} organic manure, T_3= 15 MT ha^{-1} organic manure, T_4=20 MT ha^{-1} organic manure) at different days (0,30,60,90,120) after incubation under controlled aerobic condition. The study revealed that NH_4-N content showed decreasing while NO_3-N showed increasing trends whereas available phosphorus and potassium content increased from 0 to 30 DAI and then decreased gradually up to 120 DAI.

Introduction

Maintenance of adequate levels of soil nutrients plays a key role in sustaining crop yield. Laboratory incubations are valuable and widely used tools for studying organic manure decomposition in soils which play a vital role in maintaining soil fertility.

Incubation of organic residue with soil has been used to study nutrient release from farmyard manure and pressmud compost at different days after incubation, which act as key for availability of nutrient at different period of time during crop growth. The nutrient release of an organic residue depends on its chemical and biochemical characteristics (Tian *et al.*, 1992, 1995), referred to as its quality. Residue quality and environmental conditions regulate the rate and the extent of decomposition of organic matter by soil organisms (Moorhead *et al.*, 1996). Study of nutrient release pattern from organic manures is very essential to ensure nutrient supply in adequate quantity and at proper time to crop plants. Organic matter plays a prominent role in increasing the level of soil fertility and sustaining the productivity of soils as well as the nutrients released from organic residues helps in optimizing nutrient

efficiency in agricultural crop production systems. Knowledge of the nutrients released from organic residues will enables management systems to be devised that utilize these organic residues more effectively (Villegas-Pangga *et al.*, 2000).

Materials and Methods

An incubation study has been conducted at Department of Soil Science & Agricultural Chemistry for determining the nutrients release of Nitrogen (ammonical-N and nitrate-N), available Phosphorus and Potassium from two different organic manures *viz.* FYM and Pressmud compost. The bulk soil (*Typic Haplustepts*) samples used for the incubation study had been collected from the field experimental site prior to sowing of the crop. It was air dried, finely ground and sieved with 2 mm sieve for incubation studies having initial nutrients status *viz.* mineralizable N-162.6, P_2O_5 – 43.1 and K_2O – 167.2 Kg ha^{-1}. The water holding capacity of soil was determined by Keen's cup method given by Keen-Razkowski (1921). In incubation studies duplicate of 30 gm soil samples were taken in plastic bottles and were mixed with graded doses of farmyard manure and pressmud in Completely Randomized Design. Distilled water was added to maintain the moisture at field capacity (60 per cent of the water holding capacity). The samples were incubated at 25°C and sampling for analysis of NH_4-N, NO_3-N, phosphorus and potassium of soil was done at 0, 30, 60, 90, and 120 days after incubation. The NH_4-N and NO_3-N form of nitrogen were determined immediately after taking out sample from incubator by the method illustrated by Kenny and Nelson in 1982 and rest of the soil were air dried and stored at room temperature and analyzed for phosphorus (Olsen *et al.*, 1954) and potassium (Hanway and Heidel, 1952). Initial NPK content of farmyard manure, pressmud compost were determined by the methods as outlined by Jackson (1973). Initial nitrogen of soil was determined by alkaline potassium permanganate method (Subbiah and Asija, 1956), available phosphorus was determined by ammonium–molybdate-ascorbic acid method using Spectrophotometer as outlined by Olsen *et al.*, 1954 and available potassium was determined by flame photometer after extracting the soil with neutral normal ammonium acetate, Hanway and Heidel (1952) (Table 1).

The data collected for all the characters involved under study was statistically analysed by Completely Randomized Design by the method of analysis outlined by Panse and Sukhatme (1967) for proper interpretation.

Results and Discussion

Ammonical nitrogen and nitrate nitrogen content

The amount of ammonical nitrogen in soil at different intervals of incubation of soil at 25 ^{0}C as influenced by levels and sources of organics (farmyard manure and pressmud compost) is depicted in Table 2. Results showed that the release of ammonical nitrogen was lowest in soil receiving no manure in comparison to treatment receiving farmyard manure and pressmud compost. There was decrease in ammonical nitrogen content throughout the incubation period. The decrease in the ammonical nitrogen concentration was due to nitrification and possibly immobilization and volatilization. Similar results were found by Duffera *et al.*, (1999), Mohanty *et al.*, (2010), Kolahchi *et al.*, (2012).

Result presented in Table 3 showed that the release of nitrate nitrogen was lowest in soil receiving no manure in comparison to treatment receiving farmyard manure and pressmud compost. There was gradual

increase in nitrate nitrogen from 0 to 90 days after incubation (DAI), and decreased thereafter up to 120 days of incubation. The treatment T_4 recorded highest nitrate nitrogen and was significantly higher than all the treatments. Increase in nitrate nitrogen content in case of farmyard manure from 30 to 60 days and 60 to 90 days of incubation was about 3.34% and 0.90% respectively, whereas in case of pressmud it was to the extent of 3.28% and 3.87% respectively. Results suggest that inclusion of organic material maintains considerable amount of nitrate nitrogen for longer period of time and depletes at slower rate. Availability of nitrate nitrogen increases in organically amend mended soil due nitrification of ammonical nitrogen and mineralization of rapidly mineralizable organic nitrogen. Duffera *et al.,* (1999) found that during incubation period, ammonical nitrogen concentration remained low, while nitrate nitrogen concentration increased exponentially. The low ammonical nitrogen concentration and increase in nitrate nitrogen concentration suggest that nitrification of ammonical nitrogen was proceeding faster than mineralization of organic nitrogen to ammonical nitrogen. Similar results were also reported by Mohanty *et al.,* (2010), Kolahchi and Jalali (2012).

Available phosphorus

The results obtained with respect to the content of available P in soil treated with different levels and sources of organics have been presented in Figure 1 and 2. Results show that the release of phosphorus was lower in soil receiving no organics in comparison to treatment receiving farmyard manure and pressmud compost. There was increase in available phosphorus in soil from 0 to 30 days of incubation (DAI) and there after a gradual decrease up to 120 days of incubation. Results suggested that inclusion of organic material maintains considerable amount of available phosphorus for longer period of time and depletes at slower rate. In case of farmyard manure and pressmud compost the treatment T_4 (20 MT ha^{-1} organics) recorded highest phosphorus content at 30 DAI which was at par with the treatment T_3 (15 MT ha^{-1} organics). The increase in available P content in treatment T_4 was 86% and 101% in farmyard manure and pressmud compost treated plots respectively over T_0 (control) while, the decrease in content from 30 to 60 DAI was to the tune of 1.53% and 2.2% in case of farmyard manure and pressmud compost treated plots respectively. Availability of phosphorus increases in organically amended soils due to large reduction in P sorption. Phosphorus sorption decreased possibly due to competition between phosphate ion and organic compounds that is phenolic and carboxylic and heterocyclic compound, for P retention sites in soil. The added organic forms coating on sesquioxide that reduced phosphorus fixing capacity of soil and increase the availability of phosphorus, the observation was consistent with the finding of Kumar *et al.,* (2015). After 30 days, there is decrease in available phosphorus because of liberation of organic bound phosphorus during organic matter decomposition and subsequent immobilization of excess mobilized phosphorus as reported by Singh and Patel (2016).

Table.1 Initial nutrient status of organic sources

Materials	N	P	K
Farmyard manure (%)	0.6	0.95	1.1
Pressmud (%)	1.8	2.1	1.2

Table.2 Effect of graded doses of farmyard manure and pressmud compost on NH_4-N content (mg kg^{-1}) during incubation at different days

Organic sources	Farmyard manure					Pressmud compost				
DAI / Treatments	0	30	60	90	120	0	30	60	90	120
Control (T_0)	50.39	40.74	35.60	32.80	31.00	51.99	42.58	34.21	31.90	31.20
5 MT ha^{-1}(T_1)	53.99	45.22	37.00	33.58	33.20	54.00	49.93	38.78	36.25	35.80
10 MT ha^{-1}(T_2)	57.59	48.70	39.00	36.25	36.10	57.60	52.68	41.47	38.50	38.27
15 MT ha^{-1}(T_3)	61.20	50.93	42.74	39.70	39.30	72.00	57.72	46.90	45.20	44.25
20 MT ha^{-1} (T_4)	65.00	57.72	48.00	45.50	44.90	75.00	64.51	53.78	49.80	49.65
LSD (*p=0.05*)	4.31	3.69	3.64	6.15	4.75	5.44	4.64	5.17	2.65	2.94
S.Em	1.19	1.01	1.00	1.69	1.31	1.50	1.28	1.42	0.73	0.81

Table.3 Effect of graded doses of farmyard manure and pressmud compost on NO_3-N content (mg kg^{-1}) during incubation at different days

Organic sources	Farmyard manure					Pressmud compost				
DAI / Treatments	0	30	60	90	120	0	30	60	90	120
Control (T_0)	45.26	58.63	53.72	51.31	51.00	48.57	60.00	54.63	51.71	51.50
5 MT ha^{-1}(T_1)	47.31	68.86	71.69	72.57	72.00	51.43	73.73	74.74	76.00	74.30
10 MT ha^{-1}(T_2)	49.37	79.31	80.97	83.89	81.00	57.14	84.34	87.26	91.69	90.20
15 MT ha^{-1}(T_3)	55.54	86.29	92.57	94.29	90.00	65.71	96.00	98.97	103.14	101.00
20 MT ha^{-1} (T_4)	59.66	98.86	102.17	103.09	101.00	71.43	102.63	106.00	110.11	108.00
LSD (*p=0.05*)	4.65	5.43	5.44	3.66	3.64	5.49	5.74	6.90	7.80	7.30
S.Em	1.28	1.49	1.50	1.01	1.00	1.51	1.58	1.90	2.14	2.01

Fig.1 Effect of graded doses of farmyard manure on available phosphorus content during incubation at different days

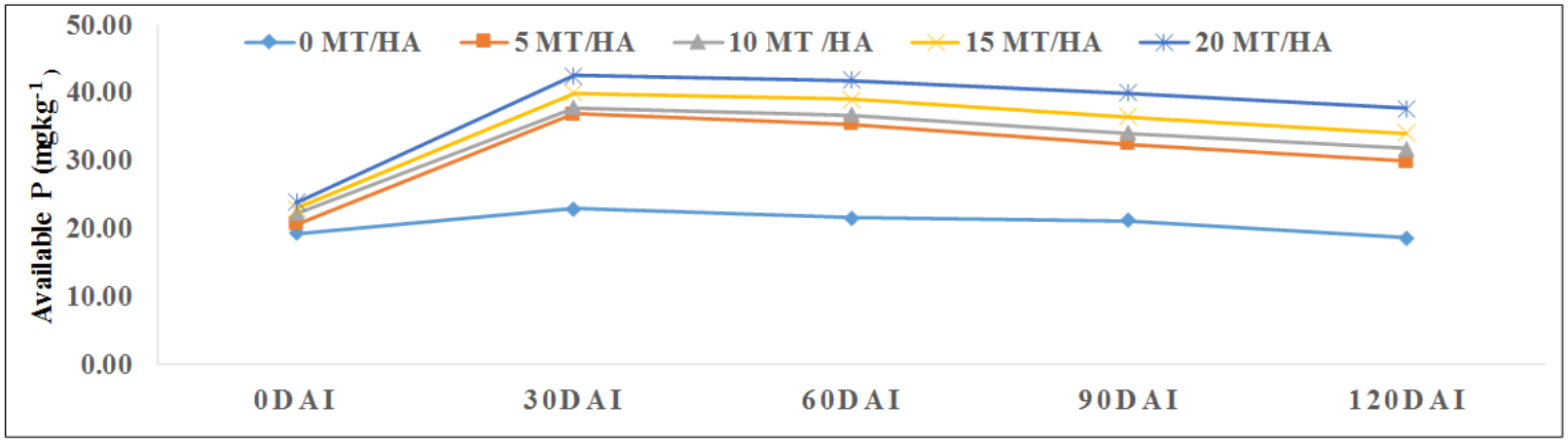


Fig.2 Effect of graded doses of pressmud compost on available phosphorus content during incubation at different days

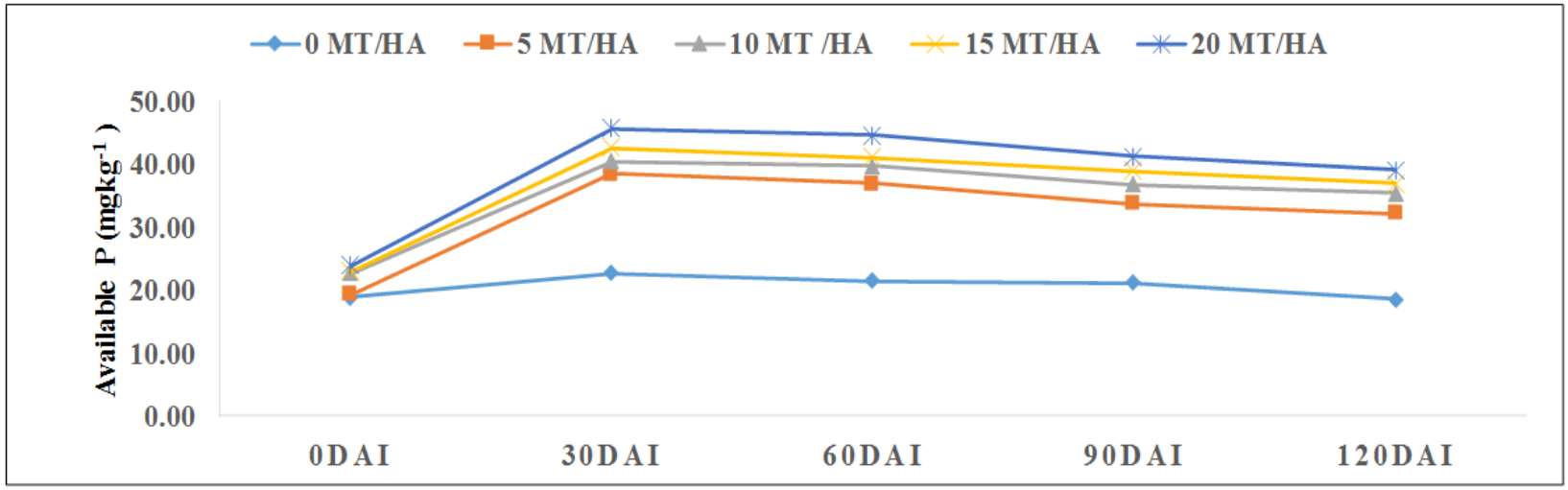


Fig.3 Effect of graded doses of farmyard manure on available potassium content during incubation at different days

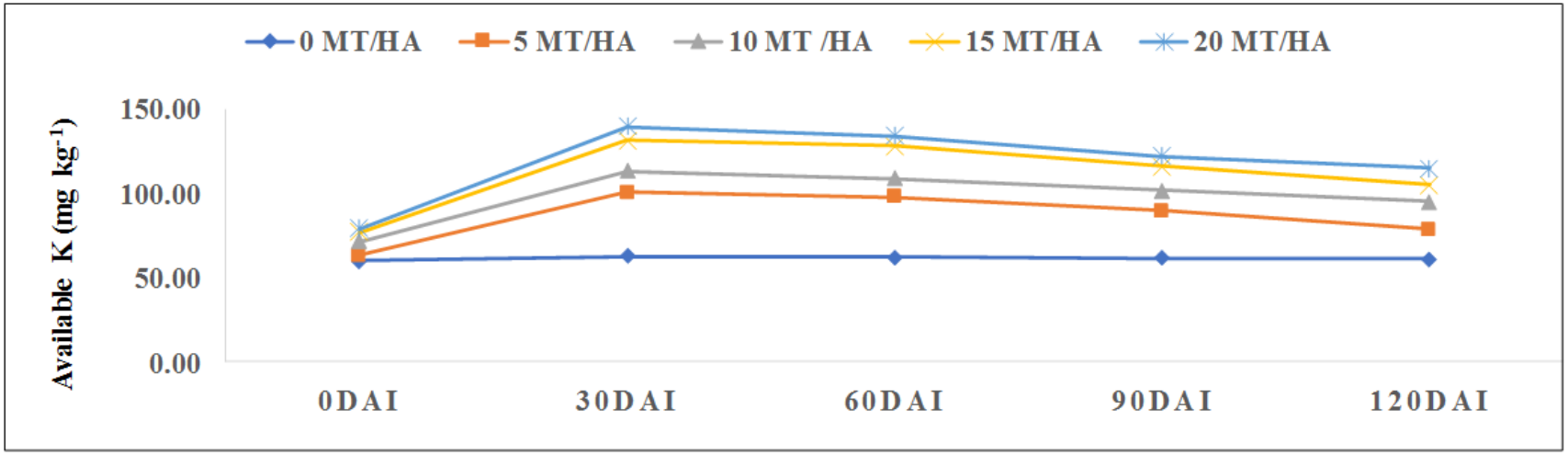
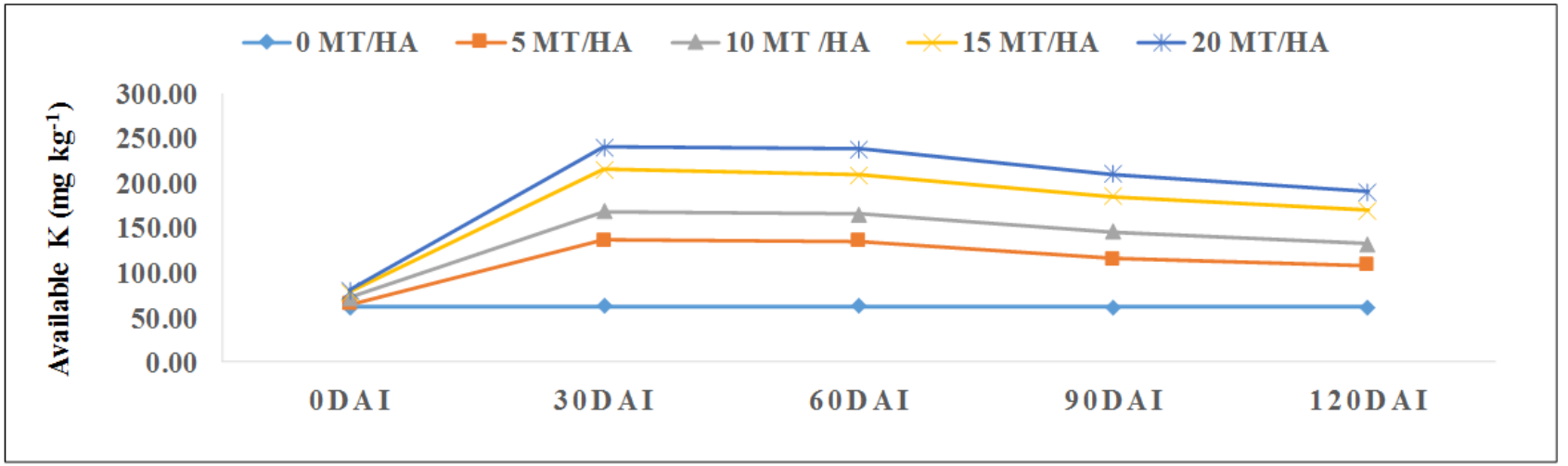


Fig.4 Effect of graded doses of pressmud compost on available potassium content during incubation at different days



Available potassium

The results obtained with respect to the content of available K in soil treated with different levels and sources of organics have been presented in Figure 3 and 4. Available potassium constitutes water soluble and exchangeable potassium. Thus the factor that changes water soluble and exchangeable K, too have effect on available K status of soil. Result shows that the release of potassium was lower in soil receiving no potassium in comparison to treatment receiving farmyard manure and pressmud compost. There was increase in available potassium from 0 to 30 days after incubation (DAI), whereas, a decrease up to 120 days of incubation. Results suggest that inclusion of organic material maintains considerable amount of available K for longer period of time and depletes at slower rate. The maximum release of K occurred at 30 DAI in the treatment T_4 (20 MT ha^{-1} applied organics), while, in case of farmyard manure, T_4 was at par with the treatment T_3 (15 MT ha^{-1} organics). Farmyard manure treated plot showed 122% increase in potassium over control whereas in case of pressmud compost treated plot the increase was to the extent of 282% over control. The rate of decrease was very slow in case of farmyard manure treated plot and was only 3.8%from 30 to 60 DAI whereas in case of pressmud compost treated plot it was 0.84%. Farmyard manure and pressmud compost is not only a source of K availability but also increases CEC of soil by increasing organic surface capable of ion exchange, resulting in an increase in exchangeable and plant available K (Blake *et al.*, 1999). Lal *et al.*, (2000) reported that with the increase in incubation time the K mineralized increased significantly and raised the available K pool in soil due to release of more organically bound potassium in course of decomposition of organic waste (Bear, 1976). Dhanorkar *et al.*, (1994) observed that increase in available K was not only due to enrichment of K by organic source but native K also become more available due to action of organic acids liberated during decomposition of organic matter. Brar *et al.*, (2008) also reported increased availability of K content in manured soil than unmanured soil. The result obtained on availability of K under incubation study was similar to findings of Kaur and Benipal (2006).

Results of incubation study indicated that the organic sources either farmyard manure or pressmud compost ensures consistent availability of nutrients throughout the growth period by augmenting microbial growth, releasing organic acids and by forming chelates with essential plant nutrients and prevent their fixation which favors availability of nutrient to crop.

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